PROCEEDINGS OF THE AMERICAN ACADEMY

II.

CONTRIBUTIONS FROM THE PHYSIOLOGICAL LABORATORY OF THE HARVARD MEDICAL SCHOOL.

A NEW FORM OF PLETHYSMOGRAPH.

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A problem which frequently presents itself to physiologists is that of measuring the changes in the size of organs, either hollow or solid, which are produced by variations in the conditions to which they are subjected. The simplest way of doing this is to fill the organ with fluid, if it is hollow, or to place it in a closed vessel containing fluid, if it is solid, and to allow the fluid thus contained within or surrounding the organ to communicate with a small glass tube, in which its rise and fall furnishes a measure of the changing size of the organ under observation. It is evident, however, that this rise or fall of the fluid changes the pressure to which the organ is subjected, and that this change of pressure, by affecting the size of the organ, introduces an error into the observation.

The Plethysmograph is an instrument devised to meet this difficulty. Its essential part is a contrivance by which the fluid is allowed to flow freely to and from the organ to be measured without changing its absolute level in the receptacle into which it flows, while at the same time a record is made of the volume of the fluid thus displaced.

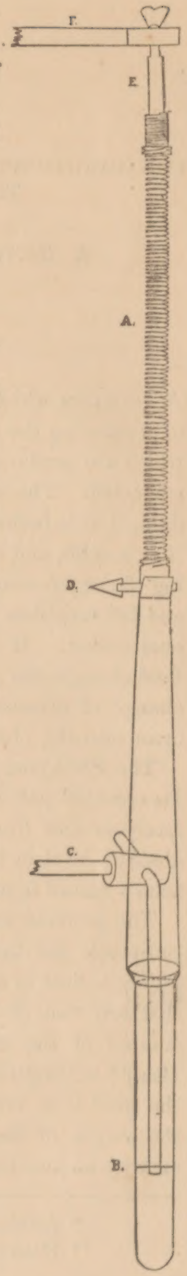
The problem was successfully solved by Mosso,* who supported the receptacle for the fluid coming from the organ to be measured by letting it float in a liquid the specific gravity of which was so adjusted that any rise of fluid in the receptacle was counterbalanced by the sinking of the receptacle in the liquid in which it floated. Von Basch† accomplished the same object by suspending the receptacle for the fluid from one arm of a balance counterpoised in such a way that the weight of the fluid entering the receptacle caused the latter to sink by an amount precisely equal to the rise of the fluid within it.

* Arbeiten aus der phys. Anstalt zu Leipzig, 1874, p. 156.

† Wiener medicinische Jahrbücher, 1876, IV.

In the plethysmograph here presented, the balance of Von Basch is replaced by a steel spring, the elongation of which, under a given weight of fluid, is equal to the rise of fluid in the receptacle. The accompanying figure shows the construction of the instrument. The steel spring A has the following dimensions:—

Length (unstretched)	95	mm.
Diam. of coil	12	"
Diam. of wire	0.55	"
Number of coils	165	



To the lower end of this spring is suspended by two threads a large-sized test-tube, B, into which enters through the bent tube C the fluid coming from the organ, the changing volume of which is to be measured. The length of the steel spring is so chosen, that the entrance of any given quantity of fluid into the test-tube B causes an elongation of the spring equal to the rise of the fluid in the test tube. The vertical portion of the tube C is of the same length as the test-tube, and since its position is such that its lower end is always just below the level of the fluid in that receptacle, the fluid will not only be driven into, but will be withdrawn from, the test-tube in precise conformity with the varying volume of the organ to be measured. A delicate metallic pointer, D, attached to the lower end of the spring A, is brought in contact with smoked paper, covering the surface of a revolving cylinder, and thus records the varying position of the test-tube B, and consequently the changing volume of the organ to be measured.

It is evident that the elongation of the spring under the weight of a given quantity of fluid will be equal to the rise of the fluid in the test-tube only so long as its specific gravity remains constant. If, therefore, the instrument is to be used with fluids of different specific gravities, a special adjustment of the apparatus will be necessary. This is most readily effected by shortening the spring A in proportion to the increase of specific gravity of the fluid used. In order to do this, it is only necessary

to screw the spring higher up on to its support, E. This support consists of a strip of brass fastened to a short pivot, which passes through a hole in a plate attached to the rod F. The width of the strip of brass, except at its lower end, is such that it lies freely within the coil of the spring. At its lower end it has a projection on each side, which give it a width a little greater than the external diameter of the coil. These projections are notched to receive a single coil of the spring, which is thus wholly supported from these notches, the part of the spring above this point being entirely unaffected by the weight of the apparatus below. In order to alter what may be called the "working length" of the spring, it is only necessary to twist the spring A upon the support E. The notches slide round upon the coils, and by thus changing the point of support alter the length of that portion of the spring which is affected by the weight attached to it. In the present apparatus it is found that the shortening of the spring by a single coil adjusts it for a fluid of 7°.48 additional specific gravity. Thus if blood (of Sp. Gr. = 1055) is the fluid used, as in measuring the varying capacity of the blood-vessels of an organ, the spring has to be shorter by 7.35 coils than in the case of distilled water.